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Wetland System to Control Water Pollution

... think scientifically, act scientifically... think scientifically, act scientifically... think scientifically, act...

EDITORIAL

Books are Important Vehicles of Science Communication

Chander Mohan

Scientific temper is a way of life. The bedrock of scientific temper is the method of science, which encompasses questioning, observing, testing, hypothesising and analysing. The role of scientific temper is essential not only to overcome myriad dogmas and superstitions but also in taking informed decisions based on awareness, facts, rationality and logic.

Public communication, which also entails presenting scientific and/or science-related topics to laymen is important to inculcate scientific temper. Department of Science and Technology (DST), through *Vigyan Prasar* (VP) and National Council for Science and Technology Communication (NCSTC) have been mandated to communicate and popularise science throughout India and thus is reaching out to the masses using various tools, techniques and technology.

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VP publications have consistently delivered scores of knowledge products, reached out to millions of fellow citizens and added value to a large number of national programs and priorities. It is one of the forerunners for training and capacity building as well as means/tools to reach the unreached.

Happy reading!

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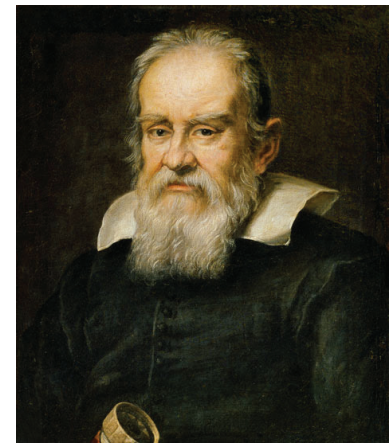
Galileo Galilei and the Birth of Modern Science

Samar Kumar Bagchi

Galileo was the first scientist who understood that mere speculation cannot advance the scientific knowledge or provide the capacity to humans to predict a phenomenon. So, he provided a new method to give a quantitative description of a phenomenon. Galileo combined experiment and mathematics together in scientific discovery. The special characteristic of science is that it does not need God or any evil spirit to explain a natural phenomenon. Galileo's intention was to find out those phenomena that are fundamental so that they can be measured and expressed by mathematical equations, which gave birth to modern science.

Four great savants of Europe gave birth to modern science. They are: Francis Bacon (1561-1626), Galileo Galilei (1564-1642), Rene Descartes (1596-1650), and Isaac Newton (1642- 1727). While Bacon and Descartes gave the Method of Science, which defined how science has to be done, Galileo and Newton gave birth to modern science.



Galileo Galilei (1564-1642)

Galileo was born at a time when European Renaissance was at its peak. William Shakespeare, the greatest efflorescence of European renaissance was also born in 1564. Renaissance in Europe brought up an upheaval in the European mind. We know that Europe went into a so-called Dark Age after the fall of Roman Empire in 576 AD. Today, the historians of science do not call the period a Dark Age because in the realm of technology, a lot of new inventions had occurred during that period. But that is a different story.

Galileo was born in the town of Pisa in Italy. Galileo's father Vincenzo Galilei was a composer and a musician. Young Galileo was nurtured by the spirit of the age of renaissance. At his young age, Galileo moved with his parents to Florence, the citadel of renaissance. At the age of 17 he got admitted in Pisa University for medical education, but he did not like to study medicine. When he was studying in Pisa, one day while visiting a church he observed the swinging of the chandelier. He measured the time period of the swing by counting his pulse-beat. He found that no matter what the amplitude of the swing was, the time period remained the same. By such observation he discovered the Law of Isochronism of a pendulum. Galileo started working with pendulums. During his time accurate time keeping was virtually none-existent. At the end of his life Galileo designed the first pendulum clock. He learnt on his own accord mathematics from an instrument maker, who introduced Euclid and Archimedes to him. Because of this he got interested in mathematics, mechanics and hydrostatics.

It was extraordinary that three gifted astronomers were working at the same time in Europe: In Prague, 54-year-old Tycho Brahe (1546-1601) was busy recording the position of the celestial bodies; Brahe's assistant, 30-year-old Johannes Kepler (1571-1630) was trying to work out the orbit of Mars by applying his mathematical genius to Tycho's planetary data; and in Florence, 36-year-old Galileo was pointing the telescope, designed and fabricated by him, at the sky to unravel the mysteries of celestial bodies.

Galileo had a natural attraction

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towards tools and implements. He became a proficient mechanist. There was a small workshop in his house where he spent a lot of time experimenting with things. In this workshop he ground and polished his own lenses and constructed a new refracting telescope through which he observed the four satellites of Jupiter,known as Galilean moons. The rings of Saturn puzzled him. He found the Milky Way to be full of stars. From his observations Galileo got confirmation of the Copernican Theory of heliocentric solar system. However, the propagation of this observation brought him to face the Inquisition. When NASA sent a mission to Jupiter in the 1990s, it was named *Galileo* in honour of the Italian astronomer.

In the 17th century, Galileo was a significant writer of Italian prose. He wrote poetry and was also a critic of poetry. For some time he gave lectures on the Italian poet Alighieri Dante. The literary value of his scientific writings is also immense. He had tremendous love for arts and music. He was a true renaissance personality and can only be compared with Leonardo de Vinci. In 1588, he gave a talk on geography in Dante's 'Inferno' at the Florentine Academy. The lecture was highly appreciated. At the age of 35, he was appointed a professor of mathematics at Pisa University. By the time Galileo died in 1642 he had almost alone given birth to modern science.

The objective of this article is not to discuss about the diverse contributions of Galileo in science. I shall try to describe how he started a completely new way of doing science. What did Galileo do in the beginning of the 17th Century that was quite new and was not there earlier?

Application of mathematics in scientific inquiry is not very new. Greek scientists and mathematicians also tried to search for mathematical models in the mysteries of nature. Plato (428 - 347 B.C.) strongly believed that the truth of the universe can be discovered through mathematics and not through experiments. Then what is the new thing that Galileo brought in the field of science?

Galileo combined experiment and mathematics together in scientific discovery. When a Greek astronomer proposed that Earth rotates round its axis, Aristotle had said that it is foolish because if a person jumps then he would fall at a different place if the Earth rotates under his feet. This is the way science has progressed: by continuous falsification of a hypothesis or theory. That is the reason we, men of science, have no *guru* (teacher) or *dharma granth* (sacred text). Sometime it is Aristotle's *Physics*, sometime Newton's *Principia*, and sometime Einstein's Theory of Relativity. Our world is wonderfully expressed by an Urdu couplet:"This life is an endless journey/when it reaches the destination/the destination advances." The world of our understanding is constantly expanding.

Galileo was the first scientist who understood that mere speculation cannot advance the scientific knowledge or provide the capacity to humans to predict a phenomenon. So, he provided a new method to give a quantitative description of a phenomenon. In the book *The Assayer* Galileo writes,"Philosophy (natural philosophy or science)is written in the grand book, the universe, which stands continually open to our gaze." He further writes that one "cannot understand unless one learns to comprehend the language and read the letters in which it is composed. It is written in the language of mathematics and its characters are triangles, circles and other geometric figures without which it is not humanly possible to understand a single word of it."

In *The Assayer* Galileo discusses about the nature of scientific method and scientific truth. He explains the primary and secondary properties of a natural phenomenon. The property that can be measured, he said, is the primary and the properties that cannot be measured are secondary. For example: taste, smell, touch, love, etc., cannot be measured; so they are secondary.

We know that if we release a body from a height it falls to the ground. Why does it fall? Many hypotheses have been provided in the past. Aristotle argued that every object has a particular place. The natural property of every object is to stay at the centre of the Earth. Hence when a body is released it goes towards the centre. Galileo did not try to find out the reason why a body falls to the ground. He observed that as a body starts falling the distance the body travels increases with time. He tried to find out the relationship between the two variable quantities: time (t) and distance (s). It is said that he experimented from the top of the leaning tower of Pisa to study the time bodies of different weights take to reach the ground. From this observation he came to the conclusion that if there is no resistance then all bodies would fall with equal rapidity. Since normally the speed of a falling body is very high, he designed experiments to reduce the falling speed by using inclined planes. By releasing a body on an inclined plane he observed that the distance travelled by the object is proportional to the square of the time of travel. He gave the mathematical relationship of a freely falling body as:

$$S=ut+ (1/2)\, gt^2$$

Where S is the distance travelled (metres), u the velocity (metres per second), t the time (seconds) and g the acceleration due to gravity.

The value of g being equal to 9.8 metres per second square, in the above example, $S=4.9t^2$,as velocity u at start is zero. This means after 1 second the object will fall 4.9 metres; after 2 seconds 19.6 metres; after 3 seconds 44.1 metres and so on. From this equation one can predict the position and velocity of a body after time t, but cannot provide the reason for the fall. Before Galileo it was basically a qualitative understanding of science. Galileo brought in quantitative understanding by the use of mathematics and experimentation. He revolutionised science and opened the door of scientific discovery.

If we consider the history of science, we will find that no significant work of modern science, whether theoretical or practical, can be explained by metaphysical, religious or mechanical means. It has been possible only through a quantitative and descriptive process. The special characteristic of science is that it does not need God or any evil spirit to explain a natural phenomenon. Galileo's intention was to find out those phenomena that are fundamental so that they can be measured and become capable to be expressed by mathematical equations.

Aristotle and later Middle Age scientists were trying to find out the origin of nature's creations, entity, quality, causal relations and composition. Galileo chose a different path. Because one cannot make quantitative measurement of those qualities, he took the help of the new philosophy of looking at nature that he and Descartes had established. Descartes had shown that the fundamental quality of nature is the motion of objects with respect to space and time. So, Galileo started analysing the different phenomena of nature like space, time,

weight, velocity, acceleration, inertia, force and momentum. He thought that these are the various problems on which inquiries have to be made to understand nature and nature's processes.

One important aspect of Galileo's viewpoint was to make a mathematical model of science. The way Euclid proved various theorems by basing itself on different axioms, Galileo and later scientists used a few fundamental axioms and then tried to come to a truth through deductive logic. If we are to evaluate the scientific contribution of Galileo, we have to understand that science is not a collection of a few experiments no matter how skilfully they have been performed. The fundamental aspect of science is that it helps in organising the findings of different experiments, that seem haphazard, to form a coherent theory to arrive at a new understanding about the physical world. To give an example: the distance of different planets from Sun is a collection of data using which Copernicus gave us the idea of a heliocentric universe. The newness of Galileo is that he brought in a connection between different data sets using a few axioms from mathematical rules.

So, we find that Galileo's method has three aspects. First, finding out the quantitative aspects of physical phenomena and then to express them in mathematical formulas. Second, separating the different fundamental properties of a phenomenon and making quantitative measurements. Third, from fundamental physical principles, using inductive logic, and arriving at scientific understanding. Galileo engaged himself to find out the fundamental laws of nature and had to completely change the kinetics of Aristotle. He published a small booklet on 'Motion' and proved the absurdity of Aristotle's views on natural and forced motion.

Aristotle thought that every object has a natural place where it wants to stay. Heavy objects according to Aristotle want to stay at the centre of Earth. He believed the centre of Earth is also the centre of the universe. The natural place for gaseous objects is the sky because gaseous objects are light. If any object does not stay at its natural place then, it will try to go back to its natural place, even if no force is applied on it. According to Aristotle, this motion of the object is its natural motion. But, if any object is thrown or pulled then the motion that the body acquires is forced motion. Hence, if a body is to have motion then a constant force has to be applied. But Galileo observed that if there is no opposition to motion due to air or friction then a body will have uniform motion in a straight line. We find this fundamental discovery of Galileo regarding motion in the first law of motion of Newton–sometimes referred to as the law of inertia– which states that an object at rest stays at rest and an object in motion stays in motion with the same speed and in the same direction unless acted upon by an unbalanced force. This property is called inertia.

What is the difference in the observation of motion between Aristotle and Galileo? Is it only a difference in observation? No, Galileo's method was different. He looked at the problem from the point of a mathematician. Ignoring resistance due to air and friction he tried to understand the motion in the complete absence of air and discovered the fundamental property of motion. By putting the problem in a geometric scheme he discovered the laws of motion.

As a geometrician conceives ideal figures, Galileo found out the laws of motion by such ideal assumptions. In geometry, the more a real triangle approaches an idealised triangle, the closer does the sum of three angles approach 180 degrees. Like the mathematician, a modern scientist idealises his problem and then tries to find out the solution.

Now, I come to the second fundamental discovery of Galileo. If a constant force is applied to a body then its velocity will constantly change. In Newton's second law we get, $F=ma$, where F is the force, m is mass of the body and a is the acceleration. From the above law we find that if acceleration is not zero then force also cannot be zero. We know that a falling body constantly accelerates; so the body must have a force applied to it. The idea that all objects are pulled by Earth had come by the time of Galileo. Galileo started making mathematical calculations of falling bodies. He saw that if the resistance of air is removed then all falling bodies will have a constant acceleration. The velocity of a freely falling body increases by 9.8 metres per second per second. So, after t seconds the velocity v of a body will be $9.8t$ metres per second, i.e. $v = 9.8t$

From this equation we understand that as time increases velocity also increases, For example, after 1 second the velocity will be 9.8 metres/s; after 5 seconds it will be 49 m/s and so on. Galileo further showed that after t seconds the distance that a falling object will cover will be $4.9t^2$ metres. For example, after 1 second the object will fall 4.9 metres; after 2 seconds, 19.6 metres; and after 3 seconds, 44.1metres and so on.

From a few fundamental rules, Galileo worked out important laws of nature. Indeed it is possible to find out by deductive process the mathematical explanation of natural laws with the help of a few natural axioms. With this method Galileo found out the laws of falling projectiles. In his famous book *Discourses and mathematical demonstration concern two Systems*, Galileo expressed all these laws and his other thoughts. He took 30 years to write the book. When he completed the book the Church went against him. After the publication of his book *Dialogue on two chief world systems – Ptolemaic and Copernican*, Galileo had to face the Inquisition in 1633 for propagating the idea of Copernicus. The Church stopped the publication of the *Discourses*. But Galileo cleverly sent a copy of the book to Holland for publication through one of his disciples. The book was published a few years before his death in 1642. With the publication of this book Galileo had laid the foundation of modern science.

Wetland System to Control Water Pollution


Gaurav Saxena and R. N. Bharagava

In recent years, constructed wetlands are gaining importance as a eco-technological wastewater treatment option around the globe, especially in developing countries, where advanced wastewater treatment technologies are neither available nor affordable. Constructed wetlands can be created at the place of wastewater discharge and have self-mitigation capacity for any unavoidable environmental impacts and therefore, are an effective means to combat the water pollution worldwide.

Sustainable management of water resources is becoming an urgent issue because of the increasing contamination and scarcity. Indeed, our natural environment is continually becoming highly stressed , which is directly linked to the deficient or non-existent wastewater treatment plants responsible for the disposal of untreated/partially treated industrial and domestic wastewaters. This unregulated practice compromises the accessibility to clean water and sanitation and thus, resulting in severe health hazards and environmental risks. To cope with these problems, wetland systems are increasingly being recognised as a potentially suitable decentralised way to combat water pollution.

In India, wetlands cover nearly 4.7% of the total geographical area of the country. Around 2,01,503 wetlands are identified across the country according to the *National Wetland Atlas* 2011, prepared by Space Applications Centre, Indian Space Research Organisation (Ahmedabad). Natural wetlands are the most productive ecosystems on the Earth and have been used as a convenient wastewater discharge sites for centuries. They play many roles in the environment, principally water provisioning, management and purification, flood control, carbon sink, ground water recharge, shoreline stability, and biodiversity maintenance. They also transform and store organic matter and nutrients and hence, natural wetlands have been called the 'kidneys of the landscape' because of their ability to store, assimilate and transform contaminants lost from the land before they reach waterways. Like a giant kidney, wetlands help to dilute and filter material that could otherwise harm our lakes, rivers and other waterways.

Fig. 1. A natural wetland at Babasaheb Bhimrao Ambedkar University, Lucknow

India is currently facing critical water shortage and serious water pollution issues. India ranks 120th out of 122 nations for its water quality and 133rd out of 180 nations for

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The authors are currently engaged in the environmental toxicity assessment of industrial wastewaters and development of ecofriendly wastewater treatment technologies.

Table 1. Wastewater: Characteristics and pollutants	
Pulp and paper mill wastewater	Highly intense dark brown colour, contains recalcitrant dioxins, furans, lignins, organic halides, phenols and chlorophenols especially pentachlorophenol
Textile wastewater	Alkaline in nature, highly coloured and often contains harmful carcinogenic dyes such as acidic, basic, reactive, disperse, azo, diazo, anthraquinone based and metal complexes dyes
Tannery wastewater	Contains high organic substances, salts (sodium, chloride and sulphide), phenolic compounds, endocrine disrupting chemicals such as nonylphenols and phthalates and other toxic metals especially chromium
Distillery wastewater	Contains high organic substances, phenols and dark black coloured recalcitrant melanoidins
Winery wastewater	Acidic in nature, contains high content of organic matter and high molecular weight recalcitrant compounds such as polyphenols, tannins and lignins
Pharmaceutical wastewater	Acidic in nature, contains many organic solvents, formulations, disinfectants and many generic drugs such as antibiotics, analgesic, etc.

its water availability. In India, drinking water resources, both surface and groundwater, are often contaminated by untreated/partially treated industrial wastewaters indiscriminately release by various industries such as tanneries, distilleries, pulp and paper mills, textile mills, etc. Industries are the key players in the economy of India, but unfortunately these are also the major polluters of the environment. The wastewater released from industries contains a variety of pathogenic bacteria, potentially toxic metals such as chromium, lead, arsenic, mercury, cadmium, etc., and harmful organic chemicals such as phenols, chlorophenols, pesticides, etc. These cause the pollution of both the surface and ground water and hence cannot be recommended for drinking purpose and irrigation of agricultural crops where pathogens may cause illness outbreaks in humans beings (Table 1). Moreover, various toxic metals and organic pollutants have been identified as "priority pollutants" as reported by United States Environmental Protection Agency (USEPA), Agency for Toxic Substances and Disease Registry (ATSDR) and World Health Organization (WHO).

Natural wetlands have been effectively used for wastewater treatment across the world for many years. Wetlands are relatively low-cost and eco-friendly wastewater treatment options and require easy installation and less maintenance as well as generate minimum secondary pollutants. They are not only used to degrade/detoxify the organic pollutants and remove nutrients from municipal sewage, storm water, and agricultural runoff, but also to remove toxic metals from mining discharge and industrial wastewaters. Natural wetlands are still used for the treatment of secondary and tertiary treated wastewater to improve the water quality but, currently, the use of constructed wetlands is preferred.

Constructed wetlands are the man engineered ecosystems that have been designed and constructed to utilise the physiological processes of natural wetlands within a more controlled and manipulated environment for wastewater treatment. Wetland systems are often planted manually or naturally colonised by dominant plant communities. Constructed wetlands contain natural processes of aquatic plants that not only accumulate toxic metals from wastewater directly into their tissues, but also act as catalysts for wastewater purification and hence, the selection of candidate plants is crucial as it directly or indirectly affects the treatment efficiencies. However, various physico-chemical and biological processes also takes place in the rhizosphere region (the narrow region of soil that is directly influenced by root secretions and associated soil microorganisms) due to the interaction between plants, microorganisms and soil/sediments and meant for the removal of various pollutants and nutrients from wastewater prior to its disposal in the environment. The plants, which are commonly used for the plantation in constructed wetlands are listed in Table 2.

Table 2. Aquatic plants used for wastewater treatment in constructed wetlands	
Common name	**Scientific name**
Indian shot	*Canna indica*
Broadleaf cattail	*Typha latifolia*
Southern cattail	*Typha domingensis*
Common reed	*Phragmites australis*
St. Augustine grass	*Stenotaphrum secundatum*
Chairmaker's bulrush	*Scirpus americanus*
Giant reed	*Arundo donax*
Glassworts	*Sarcocornia fruticosa*
Paleyellow iris	*Iris pseudacorus*
Common rush	*Juncus effusus*
Elephant grass	*Pennisetum purpureum*
Reed canarygrass	*Phalaris arundinacea*
Broadleaf arrowhead	*Sagittaria latifolia*
Vetiver	*Vetiveria zizanioides*
Umbrella plant	*Cyperus involucratus*
Asian crabgrass	*Digitaria bicornis*

Constructed wetlands provide many ecological and economic benefits; they require low capital investment for construction, low electricity consumption for operation, less maintenance. They also provide wildlife habitat as well as human recreational and tourism opportunities such as birdwatching, hiking,

Continued on page 22

Detecting Ripples in Space time

Biman Basu

Detecting gravity waves is no simple task. Even with the most sensitive instruments, detection of gravitational waves calls for extreme ingenuity, mainly because the changes observed are miniscule. Significantly, scientists from several Indian research institutions contributed substantially to the historic find. Their contribution included computer simulation studies and analysis of LIGO (Laser Interferometer Gravitational-wave Observatory) data.

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Physics laureates. (l to r) Barry C. Barish, Kip S. Thorne, and Rainer Weiss (Credit: mirror.co.uk)

Ripples in the fabric of space time, first predicted a century ago by Albert Einstein, sparked a revolution in astrophysics when their first detection was announced in early 2016. The teams involved in the discovery – Rainer Weiss, Barry C. Barish, and Kip S. Thorne – were awarded the Nobel Prize in Physics for 2017 "for decisive contributions to the LIGO detector and the observation of gravitational waves". Gravitational waves spread at the speed of light, filling the universe, as Albert Einstein described in his general theory of relativity. They are always created when a mass accelerates, like when a pair of black holes or neutron stars rotates around each other.

The story of the historic discovery goes back to the end of the 1950s, when new calculations showed that they actually carry energy and therefore should, in principle, be measurable. One piece of indirect evidence came in the 1970s when the American astronomers Joseph Taylor and Russell Hulse used the 300-m radio-telescope at Arecibo, Puerto Rico, West Indies to observe a pair of extremely dense stars, a double pulsar. (Pulsars are a kind of rapidly rotating cosmic beacon with a mass somewhat greater than that of the Sun and a radius of about ten kilometres.) They were able to show that the pulsars rotated around each other at increasing speed, while losing

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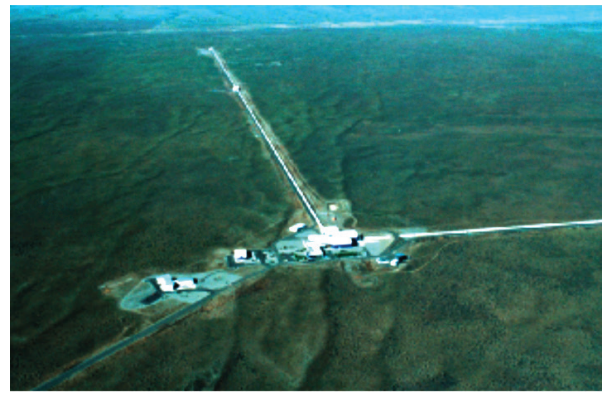
energy and moving closer together. The amount of lost energy corresponded to the theoretical calculations for gravitational waves. For their work Joseph Taylor and Russell Hulse were awarded the Nobel Prize in Physics in 1993.

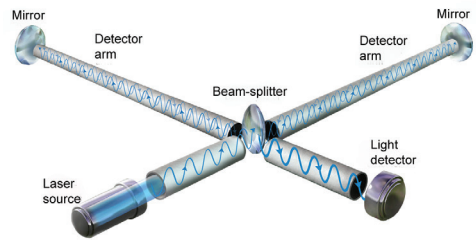
Although Taylor and Hulse were able to detect the slowing down of a pair of rotating pulsars and prove the existence of gravitational waves, they did not detect gravitational waves directly, probably because no detector was available at that time which was sensitive enough to record the extremely faint signals. Indeed detecting gravity waves is no simple task. Even with the most sensitive instruments, detection of gravitational waves calls for extreme ingenuity, mainly because the changes observed are miniscule. In principle, gravitational waves, which rhythmically stretch and squeeze space, can be detected by using interferometry. But, as was predicted by Einstein, when they arrived at Earth, gravitational waves were expected to be extremely weak and difficult to detect because of background noise.

In the mid-1970s, Rainer Weiss, a professor of physics emeritus at MIT, had already analysed possible sources of background noise that would disturb measurements. Weiss brought two fields of fundamental physics research "from birth to maturity", namely characterisation of the cosmic background radiation, and interferometric gravitational wave observation. He made pioneering measurements of the spectrum of the cosmic microwave background radiation and was co-founder and science advisor of the NASA *COBE* (Cosmic Background Explorer) satellite. His contribution in the design of the Laser Interferometer Gravitational-wave Observatory, or LIGO was to find ways of cancelling out sources of background noise such as vibrations from passing trucks or waves lapping against the ocean shore that could be mistaken for gravitational waves. He pioneered ingenious ways of suspending mirrors that would capture the tiny movements caused by gravitational waves without any worldly disturbances.

Kip S. Thorne, an American theoretical physicist, was the Feynman Professor of Theoretical Physics at the California Institute of Technology (Caltech) until 2009. He is a long-time friend and colleague of Stephen Hawking and Carl Sagan, and is one of the world's leading experts on the astrophysical implications of Einstein's general theory of relativity. Thorne's research has principally focussed on relativistic astrophysics and gravitation physics, with emphasis on relativistic stars, black holes and especially, gravitational waves. He is perhaps best known to the public for his controversial theory that wormholes can conceivably be used for time travel. Thorne joined with Weiss to develop LIGO. Early on, both Thorne and Weiss were firmly convinced that gravitational waves could be detected and bring about a revolution in our knowledge of the universe.



The LIGO detector at Hanford, Washington, USA. (Credit: Huffpost)



Structure of LIGO (diagrammatic) (Credit: sciencenews.org)

Barry C. Barish, an American experimental physicist, is a Linde Professor of Physics, emeritus at California Institute of Technology. Barish became the principal investigator of the LIGO in 1994 and director in 1997. He led the effort through the construction and commissioning of the LIGO interferometers in Livingston, and Hanford, USA in 1997. He created the LIGO Scientific Collaboration and transformed what was a small research group of 40 into a major international collaboration of 1,000 scientists to carry out the science.

The initial LIGO detectors reached design sensitivity and set many limits on astrophysical sources, but were not sensitive enough to detect gravitational waves. The Advanced LIGO proposal was developed while Barish was director, and he has continued to play a leading role in LIGO and Advanced LIGO. The first detection of the merger of two 30-solar-mass black holes was made on 14 September 2015 by the Advanced LIGO. This represented the first direct detection of gravitational waves since they were predicted by Einstein in 1916 and the first ever observation of the merger of a pair of black holes. Detecting the waves took two extremely sensitive detectors, decked out in lasers, mirrors, advanced noise filtering and the world's largest vacuum systems, to capture the tiny ripples.

Incidentally, for many years, Albert Einstein was convinced it would never be possible to measure the gravitational waves and was unsure whether the waves were real or just a mathematical illusion. His contemporary colleague, Arthur Eddington, was even more sceptical and pointed out that gravitational waves appeared "to propagate at the speed of thought". Significantly, scientists from several Indian research institutions contributed substantially to the historic find. Their contribution included computer simulation studies and analysis of LIGO data. Since the first discovery in 2015, four more events of gravitational wave detections have been recorded by the LIGO and Virgo detectors, one of which came from the collision of a pair of neutron stars.

Gravitational waves are a completely different genre of signals received from cosmic events, different from electromagnetic waves like light, infrared, ultraviolet, X-rays and gamma rays, which were hitherto the sole means of detecting cosmic events. The detection of gravitational waves has thus thrown open an entirely new field of astronomy. Till now we could learn about the universe only using electromagnetic signals. Now astronomers will be able to study the universe through gravitational waves, which may reveal new, hitherto unknown objects in future. Gravitational wave astronomy will also allow astronomers to look further back in time and deeper inside the most extreme objects in the universe including black holes. ■

Depression Needs Expression Not Suppression

Anurag Tripathi

Last few decades have witnessed a paradigm shift from a physical-work-based economy to a cerebral-work-based economy, where mental activity overrides physical activity that took the world economy to new heights. Undoubtedly these developments have led the world economy to new horizons but at the cost of human health. As per the government data more than 13% people in India are suffering from some mental disorder and 80 to 90 % such cases remain untreated due to lack of proper treatment facility or due to lack of awareness.

Depression is one of the prominent mood related mental disorders that is fast expanding worldwide. It is evident from the data released by World Health Organisation (WHO) that emphasises that more than 300 million people in the world are coping with depression and the number has increased by 18% between 2005 and 2015.Taking it as a major concern to human health, WHO kept the theme of this year's world health day (7April) as 'Depression'.The WHO is leading a one-year global campaign on depression.

Introduction

Last few decades have witnessed a paradigm shift from a physical-work-based economy to a cerebral-work-based economy, where mental activity overrides physical activity that took the world economy to new heights. Now we are passing through a decade where mental-work-based economy is shifting towards digital gadget-based economy where artificial intelligence, virtual reality, robotics, etc., are the key driving forces rather than humans. Undoubtedly these developments have led the world economy to new horizons but at the cost of human health. According to WHO, health can be defined as physical, mental and social well-being of the humans. Adequate medical facilities are available for physical diseases but medical facilities for mental health are still scarce, particularly in India. As per the government data more than 13% people in India are suffering from some mental disorder and 80 to 90 % such cases remain untreated due to lack of proper treatment facility or due to lack of awareness. Indian government is keen on this issue and the Mental Healthcare Bill, 2016, has been passed in the Lok Sabha on 27 March 2017. The bill defines mental illness as "a substantial disorder of thinking, mood, perception, orientation or memory that grossly impairs judgment, behaviour, capacity to recognise reality or ability to meet the ordinary demands of life, mental conditions associated with the abuse of alcohol and drugs".

The bill includes certain magnificent provisions like right to access mental health care for all citizen of India, operated and funded by the government and equality of treatment and protection from inhuman practices; and access to legal services. Moreover, the current bill declares the decriminalisation of attempt to suicide that was previously under the ambit of Indian Penal Code. In India, depression contributes to one third of the total cases of mental illnesses thus it needs proper attention, study and provision for treatment.

What is depression?

Depression is a mental state when people get obsessed with certain negative thoughts or situations already stored in their memory and lose their confidence in life which is manifested in their behaviour as lack of appetite, disturbed sleep, impaired cognitive functions, lack of concentration, and apathy towards their daily engagements. A depressed person continuously feels sadness and avoids social interaction. In severe depression, the patient sometimes generates a suicidal tendency.

Causes of depression

Indeed there is no single cause of depression; rather it depends on the nature and behaviour of individuals. Any untoward incident in life, like deceit in love affair or family relationship, failure in career, death of a kin, hurt sentiments, social embargo, etc., may lead an individual towards depression. In general a person gets into depression when he or she fails to meet some expectation, but ultimately gets obsessed with it which ultimately generates negative thoughts and leads towards anxiety and depression. In the modern age, excessive dependence on smart phone, computer, social media and other electronic gadgets is taking people away from social interaction and family bondage and as a consequence there is rise is cases of mental disorders like impaired cognitive function, attention deficit hyper-excitability disorder (a mood-related disorder in which, people show excess anger and lack of

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concentration). These digital related mood disorders boost the prevalence of depression, dementia (reduced memory) and other mental illnesses.

In the initial stage, negative emotions generate stress in brain due to neurochemical alterations, which if remain unattended, lead a person towards anxiety, clinical depression or post-traumatic stress disorder (PTSD). If itremains untreated for a long time, depression causes many neurochemical and neuro-anatomical changes within brain, subsequently leading a person towards impaired cognitive functions anddisturbed physiological conditions of the body. In the final stage, depression generates suicidal thoughts due to sustained input of negative impulses. At the initial stage when it is in stress phase it can be cured through proper counselling and care taken by family; but in the peak stage it needs psychiatric treatment. However,depression is a neurobiological phenomenon that results in many neuroanatomical, neurochemical and hormonal alterations. To understand the neurobiology of depression, a brief description of human brain is essential.

The human brain and the centres affected in depression

Human brain weighs about 1,400g and looks like a highly crumpled structure showing externally many ridges,grooves, and deep grooves. Anatomically human brain comprises approximately 100 billion neurons which are connected to one another through a distinct gap called synapse. One neuron is connected to approximately ten thousand other neurons through distinct and dynamic neural circuits. The brain can be divided into forebrain, midbrain, and hindbrain. The forebrain, which covers approximately 2/3 part of the total area, can be divided into cerebral hemispheres and what is commonly called interbrain. Midbrain and Medulla Oblongata (part of hindbrain) collectively constitute the brainstem which connects the forebrain to spinal cord. Brainstem regulates almost all involuntary physiological activities of the body. Cerebral hemispheres are divided into left and right parts connected to each other through the dense network of corpus callosum. Each part is divided into distinct lobes, frontal, parietal, temporal, and occipital. Each hemisphere comprises an outer cortex (grey

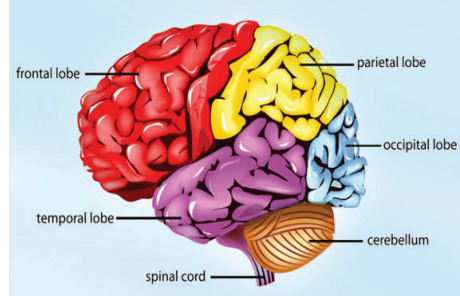

Fig.1. Structure of human brain

matter) and inner medulla (white matter). Grey matter hasa dense network of neurons that process the neuronal inputs and are responsible for cognitive functions; white matter is responsible for quick and speedy transmission of the processed information from cortical centres to other parts of the brain, particularly to the core part, for the conception, consolidation and storage of information in form of memory. The other part of the forebrain, diencephalon (also known as interbrain) consists of epithalamus, thalamus and hypothalamus. Thalamus acts as relay centre for neuronal inputs and outputs and hypothalamus regulates various physiological activities like hunger, thirst, temperature, sexual activity, etc., through autonomic and endocrine regulation. Hypothalamus is directly connected to autonomic nervous system (sympathetic and parasympathetic) and pituitary gland.

Limbic system

The core part of the forebrain consists of many distinct small centres located particularly in the temporal lobe that are connected to cortex as well as other parts of the brain through scrupulous neuronal circuits.These centres collectively constitute the limbic system which controls various emotions like pleasure, pain, anger, anxiety,

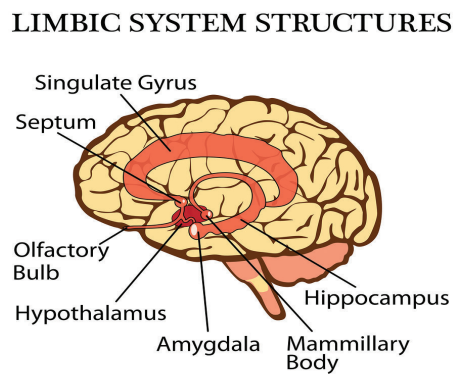

Fig.2. Components of limbic system

etc., hence it is also called emotional nervous system. The major components of limbic system are prefrontal cortex, amygdala, hippocampus, septum, singulategyrus, and hypothalamus. The prefrontal cortex is the CEO (chief executive officer) of the brain or the extreme centre of consciousness that can regulate the rest of the brain through consciously generated thoughts, sending its neuronal output to other components of limbic system. Amygdala is known as the centre of fear, anger and anxiety. Hippocampus receives the inputs from amygdala and frontal cortex and consolidates the information in form of long-term memory which is further stored in different cortical parts that is termed as subconscious mind. Septum generates the sense of immense pleasure and singulate gyrus acts as a decision-making centre between intellect and emotions. In depression, most of the limbic components are severely impacted,from hyperactivity in amygdala and its enlargement, to disrupted activity of hippocampus which fails to consolidate new information and loses its capacity to form new neurons.

Neuroendocrine alterations in depression

When the limbic system receives any kind of negative input from the cortical centres of the brain, whether actual or hypothetical (generated due to obsessed negative thinking), the amygdala gets exited which gives emotional touch to the information, consequently hippocampus processes this negative emotion and intensifies it. The input of negative thought is sent to hypothalamus either directly from amygdala or through hippocampus. Hypothalamus stimulates the autonomic nervous system and the sympathetic nervous system gets stimulated due to which the breathing rate, heartbeat and metabolic activity is enhanced to counter the situation, which persists for 2to3 seconds.It further stimulates the adrenal medulla to secrete adrenaline hormone which persists in blood for 20 to 30 seconds and enhances the metabolic rate. Finally the hypothalamus, on getting the continuous negative input, secretes neuropeptide, corticotrophin releasing factor (CRF). CRF stimulates the cells of pituitary gland to secrete adrenocorticotrophic hormone (ACTH),

which further stimulates the adrenal cortex to secrete cortisol which is also called stress hormone. This pathway which starts with hypothalamus and ends with adrenal cortex, is called, hypothalamus-pituitary-adrenal axis (HPA axis).

In depression the HPA axis is highly active and in prolonged stress condition the level of thyroid, vasopressin hormone is also increased. This occurs to enhance the metabolic activity to cope with the stress condition whether it may be actual or due to hypothetical negative emotion because body recognises only the command of hormones and neurotransmitters. Recently it has been established that the chemicals secreted by immune cells have their receptors in brain also and these act as mood enhancer and in depression the immune system of the body is severely affected. Thus in depression, neuro-endocrine-immune system of the body gets impaired.

Neurochemistry in brain during depression

Inside the brain in depressed condition, the level of neurochemical dopamine, which is responsible for, motivation and goal setting, isreduced. The level of serotonin which enhances the pleasant mood is also reduced. Level of glutamate is also reduced which isa neuro-inhibitory neurotransmitter. Adrenaline and cortisol level increases within the brain which inhibits the secretion of dopamine, serotonin and oxytocinand has a soothing effect onbrain . The level of brain derived neurotrophic factor (BDNF) which promotes permanent memory by boosting neuronal connections drops. The level of endorphins which generate happiness and relax the brain is inhibited. In the long term, depression promotes the degeneration of neurons, impaired memory, and loss of cognitive functions and reduced learning capacity.

Symptoms of depression

A person suffering from depression exhibits the following symptoms in form of altered behaviour:

1. Continuous feeling of sadness without any serious reason.
2. Irritation and anger on small incidents.
3. Feels loneliness and loses interaction with people, even with family members and secludes himself.
4. Lack of appetite and thirst; impaired digestive activity.
5. Disturbed sleep (insomnia).
6. Loss of confidence, motivation and urge to achieve some goal.
7. Person often feels restlessness due to hyper-excitability of the nervous system, increased metabolic rate, increased blood pressure and lack of sound sleep.
8. Person avoids laughing or pleasure even in pleasant condition.
9. In critical condition, patient shows reduced cognitive function and decision making power. In long term, the communication skill and concentration is also impaired.
10. In extreme situation, patient develops suicidal tendency.

Prophylaxis and treatment

It is ofutmost significancethat one should be watchful about one's changing mood. Proper care and awareness may keep people away from depression and other mental illnesses. Our physiological activities are driven by the circadian rhythm or the natural body clock, thus we should try to live a disciplined life with a set time of sleep and arousal.

1. Late night engagements and excess dependence on electronic gadgets should be avoided.
2. We should spend quality time with our family, friends. Social interactions must be preferred than social media.
3. Use of alcohol, drugs and energy drinks must be avoided.
4. Regular exercise, practice of yoga and meditation must be a significant part of daily routine.We should spend at least 30 minutes daily in these practices.
5. One should practice to live with unconditional happiness and one must realise that none can control the external incidents thus one should try to adapt oneself for any situation with satisfaction.
6. Continuous urge for happiness keeps a person away from mood-related disorders, thus we should make happiness a habit and we should enjoy every moment of life with an attitude of gratitude.
7. If someone feels sadness he/she must engage him/herself in to some creative work like gardening, listening to good music, visiting new places, reading motivational books, watching motivational videos and giving new task to brain. Continuous follow up of these practices suppresses the negative emotions and replaces it by self-esteem, confidence and positive thought.
8. When negative thoughts continuously prevail one should be awareand it should be replaced by focussing one's attention towards positive thoughts and meaningful goal of life.
9. Awareness must be spread in society that any mental illness is just like a physical illness and proper treatment and care canfully cure it. It is not a matter of shame or hiding but it is just a curable disease. Thus a patient suffering from depression needs proper family care.
10. When clinical symptoms are visible one must have quick visit to a psychiatrist and medicines must be taken regularly as per the prescription. Medicines must be changed or its dose must be altered only on the prescription of trained psychiatrist.
11. Continuous practice of exercise, yoga, deep breathing and other relaxation practices like music, art, meditation etc., give the fast healing response in depression but these practices should be done along with proper medication.
12. Many natural products and practices help reduce depression, like exposure to sunlight induces the level of serotonin; milk is also a good source of serotonin. Deep breathing and the practice of *pranayam* reduce the anxiety level by inducing the secretion of endorphins and oxytocin and reducing the level of cortisol. Drinking water, eating citrus fruits like strawberry, watermelon, and orange also enhances the mood and reduces depression level.

Thus it is a totally curable disorderand only needs proper care and treatment. A person suffering from depression or feeling anxiety must express his thoughts and must engage in social activities and creative works. Thus depression needs expression not suppression.

Survival in Deserts

Dr. Amrita Singh

The concept of a desert as an uninhabited wasteland is not correct. Deserts are unique natural habitats with their incredibly diverse flora and fauna and have been home to some of the world's oldest civilisations. Besides, we should always remember that the desert is easily damaged and is very, very slow to recover. Thus, fragile beauty and unique heritage of world's deserts deserve protection.

Intense solar radiation, lashing winds, and little moisture, i.e., less than 25 centimetres of annual rainfall create some of the harshest living conditions in the biosphere called 'hot desert'. In hot desert, generally with cloudless skies, the Sun quickly heats the land by day, producing the highest air temperatures (up to 57.8°C recorded in Death Valley, California) in the biosphere. In contrast, the nights are very cold as the temperature goes down tremendously due to loss of heat into the atmosphere through radiation. There is little water and temperatures vary widely; one may bake during the day and freeze at night. High temperatures during daytime and persistent winds accelerate water evaporation and transpiration of water vapour from plants. High evapotranspiration and low rainfall characterise all deserts, producing sparse perennial vegetation of widely spaced shrubs. The winters are quite cold, temperatures sometimes dropping below freezing point, while the heat during summer is intense and scorching. Scarcity of rainfall in deserts may be due to high subtropical pressure (Sahara and Australian deserts), geographical position in the rain shadows (western North American deserts) and due to high altitude (Tibetan, Bolivian or Gobi deserts).

Deserts cover about 14 percent of the Earth's land and occur mainly near 30° north and south latitude where global air currents create belts of descending dry air. Some deserts are also produced in the rain shadows of high mountain ranges, leeward slopes that face away from incoming storms and thereby receive little rainfall. Most deserts receive some rain during the year and have at least a sparse cover of vegetation. Annual net primary productivity of true deserts is less than 2,000 kg per hectare. The dominant soils of the arid zone are light-textured and devoid of any significant structural development. These are prone to severe wind erosion. They have very low water retention capacity, high infiltration rate and low hydraulic conductivity. Water is hardly retained in desert soil as it is not soaked into the ground, and rushes off in torrents. The moisture in the arid zones is insufficient to support living beings. But despite such harsh living conditions, deserts exhibit a spectacular biological diversity. A large number of plant and animal species thrive in the deserts due to their morphological, anatomical, physiological and behavioural adaptations.

Plant adaptations

Plants have evolved many adaptions for surviving the rigours of the desert. There are three life-forms of plants that are adapted to deserts: a) ephemeral annuals, b) succulents, and c) desert shrubs.

Ephemeral annuals are also known as 'drought evaders' or 'drought escapers'. They germinate, grow, flower, and release seeds within the brief period (6-8 weeks) when water is available and temperatures are warm. The seeds remain dormant, resisting drought and heat, until the following spring. The seeds wait out adverse environmental conditions, sometimes for decades, and will germinate and grow only when the right conditions are available. With their small size and large shoots in relation to roots, these

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plants are well adapted to dry habitats. They escape dryness in both external and internal environments. The annual forbs (herbaceous flowering plants that are not a grasses) and grasses in all deserts may make quite a show during brief wet periods. Desert sunflower and desert marigold complete their life cycles during brief rainy seasons.

The succulent plants suffer from dryness in only external environment. Their succulent, fleshy stems, leaves and roots serve as water storage organs which accumulate large amounts of water during brief rainy seasons. Opuntia, Aloe, Euphorbia, Yucca and Agave have mastered the art of enduring in the desert environment by economising in their expenditure of moisture. They rely on their waxy coatings, spongy stem and/or leaf tissues, root structures and their night-time stomata openings to carefully regulate their water use. At night the temperatures are lower and humidity higher than during the day, so less water is lost through transpiration. Such plants are sometimes called "drought endures". In Opuntia spp.(cactus), the stem modified into a thick, fleshy, green, life-like structure called phylloclade (Fig.1) manufactures food by photosynthesis and conserve water. Their leaves modified into spines which retard transpiration, promote dew formation at their tips, protect from insolation and from thirsty animals. The bulk of the tissue consists of large, round, pitted, parenchymatous (the basic tissue of plants, consisting of cells with thin cellulose walls) water-storing cells. The cell sap is mucilaginous (having the properties of an adhesive) which helps in checking evaporation of water. The extensive shallow root systems are usually radial, allowing for the quick acquisition of large quantities of water during the rainy period. The leaves are fleshy in Aloespp with marginal spines and a large water-storing tissue. The succulent *Euphorbia*spp. has succulent stem which store large quantities of water during rainy season. It contains toxic milky latex that irritates skin and eyes. The stipules (small leafy outgrowths at the base of a leaf or its stalk) become modified into spines. The toxic substances and spines prevent them from predator animals. The Century plant (Agave spp.) has saw-toothed leaves with waxy coatings that render them nearly waterproof and so prevents loss of water. The leaves of these plants channel rain water to the plant's base. It also contains toxic chemicals like oxalate crystals and irritating substances that can irritate the skin and mucous membranes and can cause digestive problems in their predator animals. The Joshua tree (Yucca spp.) is a very tough plant (Fig.2). The leaves are stiff and very pointed. In Asparagusspp. the roots become fleshy to store water.

Fig 1

Fig 2

The desert shrubs or non-succulent perennials suffer from dryness both in their internal as well as external environments. Their morphological and physiological features include rapid elongation and extensive root system, high osmotic pressure and endurance of desiccation, ability to reduce transpiration and reduction in size of leaf blade. In Alfalfa spp. root system is very extensive–more than 30 metres long to siphon deep groundwater supplies. There is waxy coating and sunken type of stomata on leaves, which reduces loss of water during transpiration. Desert grasses have rolled and folded leaves so that the sunken stomata become hidden to minimise the rates of transpiration. In all desert individual plants are scattered thinly with large bare areas in between. These spacing reduces competition for a scarce resource; otherwise intense competition for water might result in the death or stunting of all of the plants.

The grasses (bunchgrass) in desert also grow in isolated tufts. During extremely hot and dry period, the parts of the plants that are above the land may wither and die, but the root systems remain alive. Desert mariposa and desert lily have bulbs that may remain dormant for several years until a deep soaking rain awakens them. The extensive bare ground in deserts is not necessarily free of plants. Mosses, algae, and lichens may be present which form a stabilising crust on sands and soils.

Animal adaptations

Desert animals are much more affected by extremes of temperature than desert plants because the biological processes of animal tissue can function properly only within a relatively narrow temperature range. When this range is exceeded, the animal may die. Thus, most of desert animals rely on their behavioural, physiological and structural adaptations to avoid the desert heat and dryness. The drought evader animals adopt either a short annual life cycle that revolve around the scanty rains or undergo aestivation (e.g., ground squirrel). During aestivation, the breathing, heartbeat and other body activities slowdown, which in turn decrease the need of water. Many lay eggs that survive until the next rains when they hatch in the transient puddles. With the onset of rains, a variety of animals like grasshoppers, butterflies, bees, beetles, spiders, etc., may be seen in desert. Amphibians like Spadefoot toad dig burrow with the help of its spade-like feet and goes to sleep till the rains arrive. It can undergo aestivation for 8-10 months. The birds make nest and reproduce during the rainy season when there is abundant food.

The drought-resistant animals are active and carry their normal function throughout the year. They circumvent aridity and heat through morphological and physiological adaptations or by modifying their feeding and activity patterns. They remain in cool, humid underground burrows during the day time and search for food only at night when temperatures are lower. Some desert-living rodents that are active in the day periodically seek burrows and passively lose heat through conduction by pressing their bodies against the burrow walls. The desert toad uses a survival strategy similar to that employed by succulent plants. It stores water in its urinary bladder. The reptiles and some insects are pre-adapted to the hot desert environment. They excrete a dry metabolic waste product in the form of uric acid and guanine so that water loss

is minimal. They have thick waterproof skin that also minimises water loss. Desert spiders, mites and insects secrete a waxy layer over their cuticles. Wax is impermeable to water thus prevents loss of water from their bodies.

Mammals as a group are not well adapted to desert life because they excrete urea as an aqueous solution, which involves the loss of much water. Most of the mammals like the kangaroo rat, the pocket mouse and the jerboa have adapted nocturnal habitat. They seal their burrows by day to keep their chamber moist, and can live throughout year without drinking water. They feed on dry seeds and dry plants even when succulent green plants are available. They remain in burrows during the day, and conserve water by excreting very concentrated urine. Thus, adaptation to deserts by these rodents is as much behavioural as physiological. Other desert mammals like the mule, deer and elka void the extreme temperatures of the day by limiting activity hours to dawn and dusk. The wood rats survive in parts of the desert by eating dry food as well as succulent cacti or other plants that store water. Jackrabbits and kit fox have large ears that reduce the need of water evaporation to regulate the body temperature. Their ears release heat during their resting periods in a cool, shady place.

The camel can go for long periods without water because its body tissues can tolerate elevation in body temperature and a degree of dehydration. However, it uses water for temperature regulation. The body temperature of camel drops to 33.8°C overnight and rises to 40.6°C by day when the animal begins to sweat. Unlike the popular belief, camels do not store water in their hump. Their hump stores fat which yields water after its metabolic oxidation. The kangaroo rat and jerboa have long legs, which help them in jumping and swift running as well as in lifting the body above the ground and thus reducing direct contact with the hot sand. Desert gerbils have hairy soles on their feet which allow them excellent traction on sand. The sand rat feeds on plants that have very salty sap which can be toxic in large quantities. Thus, rats simply retain the water and excrete urine that is about four times as salty as sea water. The desert birds utilise a salt gland to help in the maintenance of water balance. They occasionally drink water from dew or other sources. They also avoid stressful desert conditions by simply flying to less hostile areas.

Thus, these unique natural habitats (deserts) with their incredibly diverse flora and fauna have been home to some of the world's oldest civilisations. Therefore, the concept of a desert as an uninhabited wasteland is not correct. Besides, we should always remember that the desert is easily damaged and is very, very slow to recover. Thus, fragile beauty and unique heritage of world's deserts deserve protection. ■

Wetland System to Control Water Pollution

(continued from page 30)

and picnicking. These systems also provide a reuse and recycling option for wastewater treatment facility; discharge of treated wastewater can augment surface water sources for existing water bodies round the year, thus ensure the flow and enhance the local natural aquatic resources. Constructed wetlands are also considered an environmental assets by many regulatory agencies in the world and are designated as one of the recommended "best management practices" for controlling the urban water pollution. Constructed wetlands can replace natural wetlands damaged or lost due to uncontrolled discharge of wastewater, agricultural practices and urban development.

To sum up, constructed wetlands are highly efficient and low-cost alternatives to conventional wastewater treatment plants that require large capital investments for construction, high operating costs and continuous mainstenance. Constructed wetlands have been commercially used for wastewater treatment in European and American countries as they meet secondary treatment discharge limits. Constructed wetalnds may provide an eco-friendly solution for pollutants removal from wastewaters and income can also be generated, if planted with local plants such as common reeds (*Phragmites australis*) and elephant grass (*Pennisetum purpureum*), which are used for the production of goods and cattle feed, respectively. However, construction/installation of constructed wetlands requires a large land area, but these systems are very economical in case of tropical developing countries, where land is easily available and affordable. In recent years, constructed wetlands are gaining importance as a eco-technological wastewater treatment option around the globe, especially in developing countries, where advanced wastewater treatment technologies are neither available nor affordable. Constructed wetlands can be created at the place of wastewater discharge and have self-mitigation capacity for any unavoidable environmental impacts and therefore, are an effective means to combat the water pollution worldwide. ■

Form IV (see rule 8)

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I, Manish Mohan Gore do hereby declare that to the best of my knowledge and belief, facts mentioned above are true.

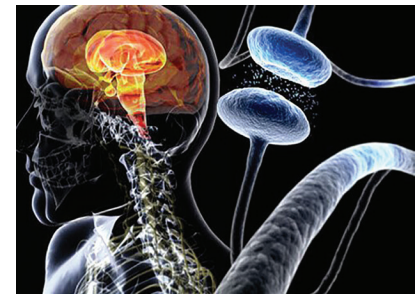
Sd/-
Manish Mohan Gore

Simple Mantras of Living with Parkinson's disease

Dr Yatish Agarwal

Parkinson's disease is a progressive disorder of the nervous system. A chronic disease, it affects a number of functions, both voluntary and involuntary. Although Parkinson's disease can't be cured, medications and making adjustments may markedly improve the quality of your life.

Parkinson's disease is a progressive disorder of the nervous system. A chronic disease, it affects a number of functions, both voluntary and involuntary, and in both bodily and intellectual zones. In general, the disease tends to progress gradually, sometimes with a barely noticeable tremor in just one hand being the first sign. In this the early stage of the disease, a person's face may become mask-like showing little or no expression, and the arms may cease to swing when a person walks. The speech may become soft and inaudible or slurred. Other symptoms may also define the condition.



Overall, since the disorder progresses with the passage of time, the signs and symptoms associated with the disease tend to grow worse over the years. A basic understanding of the course of the disease, therefore, is critical from the standpoint of living well with the disease. Mapping the advancement of disease is of significance in management and prognosis and may help the affected person and the family in taking appropriate steps in time.

Course of Parkinson's disease

If a person has Parkinson's disease, he or she is likely to wonder how the condition will unfold. They might want to know how the symptoms might worsen, and how they'll affect their life. Such a thought is natural, but Parkinson's is a hard to predict disease. It does not follow a set course, and it is hard to pin down exactly how it will progress.

The disease has two main sets of possible symptoms. One affects a person's ability to move and leads to motor issues like tremors and rigid muscles. The other set is of non-motor symptoms, like pain, loss of smell, and deterioration in cerebral function. Firstly, a person may not get all the symptoms. And secondly, nobody can quite predict how bad they'll be, or how fast they'll get worse. For instance, "person A" may have slight tremors but severe cognitive decline. While a "person B" might have major tremors but no issues with thinking or memory. A third scenario could have someone who may have severe symptoms all around.

On top of that, the drugs that treat Parkinson's work better for some people than others. In essence, it is a disease that's very hard to predict. In general, while the disease advances at different paces for different people, changes tend to come on slowly. Symptoms usually get worse over time, and new ones will crop up along the way. The disease can change the quality of life in a major way. After about 10 years, most people will have at least one major issue, like a physical disability or cognitive decline.

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Recognizing the progression of disease

You might break the disease into mild, moderate, and advanced stages. This particularly applies to motor symptoms:

Mild stage

Symptoms are a bother, but they usually do not stop you from doing most tasks. Medicines usually work well to keep the symptoms at check. A person with Parkinson's disease might notice the following changes in their body:

- The arms don't swing as freely when you walk
- You can't make facial expressions
- Your legs feel heavy
- Posture becomes a little stooped
- Handwriting gets smaller
- Your arms or legs get stiff
- You have symptoms only on one side of your body, like a tremor in one arm

Moderate stage

Often within 3 to 7 years, you'll see more changes. Early on, you might have a little trouble with something like buttoning a shirt. At this point, you may not be able to do it at all. You might also find that the medicine you take starts to wear off between doses. You can expect:

- Trouble swallowing
- Falls to be more likely
- Trouble with balance and coordination
- Slower movements
- Small, shuffling steps

Advanced stage

Not everybody with Parkinson's disease becomes this bad. The medications do not help as much and serious disabilities are likely to set in. At this point, the person is likely:

- To be limited to bed or a wheelchair
- Can't live on their own
- Has severe posture issues relating to the neck, back, and hips
- Needs help with daily tasks

Non-motor signs of progression

A person with Parkinson's disease is likely to experience one or more of the following symptoms. These symptoms can show up almost any time, but they follow a broad trend:

- Early signs
- Constipation
- Depression
- Loss of smell
- Low blood pressure when you stand up
- Pain

Some people also might get these symptoms later in the disease. In any case, if you have them, it does not necessarily mean you have Parkinson's disease.

Others might have mild issues with thinking and planning, like forgetfulness, a shorter attention span, and a hard time staying organised. Drooling and a more urgent need to pee are also common.

Later signs

Some people with Parkinson's disease may develop dementia and psychosis. They are two serious mental health issues that usually take a while to show up.

Psychosis is a serious condition where you see or hear things that aren't there, or believe in things that aren't based in reality.

Dementia means you can no longer think, remember, and reason well enough to carry on your normal life.

As you age, you're more likely to have both conditions the longer you have Parkinson's.

Seeing a doctor

You must see a doctor if you feel you may have any of the symptoms which may possibly be associated with Parkinson's disease. This would help make a diagnosis whether the symptoms relate to Parkinson's disease or to some other condition. Many clinical conditions can produce similar symptoms as Parkinson's disease.

You're likely to first see your family physician. However, you may then be referred to a specialist doctor, a neurologist, who is particularly trained to handle diseases of the nervous system.

Prepare for the doctor's appointment

It is a good idea to prepare for your doctor's appointment. That way, you will be able to convey all the symptoms you're experiencing, and will be able to voice all your concerns which may have a close bearing on the doctor being able to diagnose your condition. Write down the duration since you have come to experience these bodily changes, and if any major stresses or recent life changes have preceded the symptoms.

Make a list of all medications, vitamins and supplements that you›re taking, because it is just possible that the symptoms may be related to a drug you›re taking. Some drugs are known to produce adverse reactions which lead to Parkinson-like features.

It may be best if you were to ask a family member or friend to come with you, if possible. Besides the emotional support that this offers, the person who accompanies you may be able to help you remember something that you missed or forgot while discussing it with the doctor.

Write down the questions you may wish to ask your doctor. Your time with your doctor is limited, so preparing a list of questions ahead of time will help you make the most of your time together. For instance, you may wish to know the likely explanation of your symptoms; the tests you might need and how they would benefit you; the likely course of your disease; what treatments are available, and which may work best for you; what types of side effects could be expected from the treatment; what might be needed in the long run; and should you have any other pre-existing health conditions, how best can those be managed. Be forthright, and do not hesitate in asking any questions that occur to you during your time with your doctor.

Your doctor would also likely ask you a number of questions. You must carefully record such facts as when did you first begin experiencing the symptoms; if you have symptoms all the time or do they come and go; if anything seems to improve your symptoms; if anything seems to make your symptoms worse. Being ready with such answers can help you and your doctor make the most of the time s/he may have on hand for you.

Knowing the diagnosis

No test exists which can make a specific diagnosis of Parkinson's disease. The neurologist is a specialist doctor trained to diagnose Parkinson's disease based on a person's medical history, a review of their signs and symptoms, and a neurological and physical examination.

Still, following the clinical examination, the doctor may order certain tests, such as specific blood tests, to rule out conditions that may be the cause of similar symptoms.

Imaging tests — such as MRI, SPECT and PET scans — may also be used to help rule out other disorders. However, these tests aren't particularly helpful for diagnosing Parkinson's disease.

Once the diagnosis is confirmed, your doctor is likely to prescribe you carbidopa-levodopa, a Parkinson's disease medication. This medicine must be taken in a sufficient dose for it to be effective. If taken in an inadequate dose, the drug may not exhibit any benefit. A significant improvement with this medication will often confirm the diagnosis of Parkinson's disease.

If you've received a diagnosis of Parkinson's disease, you'll need to work closely with your doctor to find a treatment plan that offers you the greatest relief from symptoms with the fewest side effects. You and your family must recognise that although presently there is no cure for Parkinson's disease, in most people medications can help control the symptoms, often dramatically. A few cases may also benefit with surgery.

Living with Parkinson's disease requires tonnes of patience, perseverance and determination. You would in all probability benefit with healthy eating, regular aerobic exercises, physical therapy that focusses on stretching and teaching you how to maintain balance, and a speech-language therapist who may help improve your speech.

Steps you can take

Certain lifestyle changes may also help make living with Parkinson's disease easier. Under your doctor's guidance, you could try making the following adjustments:

Healthy eating

While there's no food or combination of foods proven to help in Parkinson's disease, some foods may help ease some of the symptoms. For instance, eating foods high in fibre and drinking an adequate amount of fluids can help prevent constipation that is common in Parkinson's disease. In general, a balanced diet that provides all the critical nutrients shall be beneficial for you. No food is forbidden or taboo quite contrary to what some may have you believe.

Exercise

Exercising may increase your muscle strength, flexibility and balance. Exercise can also improve your well-being and reduce depression or anxiety.

Your doctor may suggest you work with a physical therapist to learn an exercise programme that works for you. You may also try exercises such as walking, swimming, gardening, dancing, water aerobics or stretching.

Parkinson's disease affects your ability to move, but exercise can help to keep muscles strong and improve flexibility and mobility. Exercise will not stop Parkinson's disease from progressing; but, it will improve your balance and it can prevent joint stiffening.

You should check with your doctor before beginning any exercise programme. Your doctor may make recommendations about the types of exercise best suited to you and those which you should avoid; the intensity of the workout (how hard you should be working); the duration of your workout and any physical limitations.

The type of exercise that works best for you depends on your symptoms, fitness level, and overall health. Generally, exercises that stretch the limbs through the full range of motion are encouraged.

Here are some tips to keep in mind when exercising:

- Always warm-up before beginning your exercise routine and cool down at the end.
- If you plan to work out for 30 minutes, start with 10-minute sessions and work your way up.
- Exercise your facial muscles, jaw, and voice when possible: Sing or read aloud, exaggerating your lip movements. Make faces in the mirror. Chew food vigorously.
- Try water exercise, such as water aerobics or swimming laps. These are often easier on the joints and require less balance.
- Work out in a safe environment; avoid slippery floors, poor lighting, throw rugs, and other potential dangers.
- If you have difficulty balancing, exercise within reach of a grab-bar or rail. If you have trouble standing or getting up, try exercising in bed rather than on the floor or an exercise mat.
- If at any time you feel sick or you begin to hurt, STOP.
- Select a hobby or activity you enjoy and stick with it. Some suggestions include: gardening; walking; swimming; water aerobics; yoga; tai chi.

Avoiding falls

Parkinson's disease can disturb your sense of balance, making it difficult to walk with a normal gait. You may try and imbibe the following suggestions which will help reduce falls:

- Try not to move too quickly.
- Aim for your heel to strike the floor first when you're walking.
- If you notice yourself shuffling, stop and check your posture. It is best to stand up straight.
- Look in front of you, not directly down, while walking.

In the later stages of the disease, you may fall more easily. In fact, you may be thrown off balance by just a small push or bump. The following suggestions may help:

- Make a U-turn instead of pivoting your body over your feet.
- Distribute your weight evenly between both feet, and don't lean.
- Avoid carrying things while you walk.
- Avoid walking backward.

Daily living activities

Daily living activities — such as dressing, eating, bathing and writing — can be difficult for people with Parkinson's disease. An occupational therapist can show you techniques that make daily life easier.

Never lose heart

Although Parkinson's disease can't be cured, medications and making adjustments may markedly improve the quality of your life. Still, should you feel low or depressed, talk to your family members and share your concerns with them. If it still does not work, consult a mental health specialist — a psychologist or psychiatrist, depending upon the severity of your symptoms. Counselling and medicines can help.

In those occasional cases of Parkinson's disease, where medications produce no relief, your doctor may suggest surgery to regulate certain regions of your brain and improve your symptoms. ■

{Next month: Parkinson's Disease – Knowing About Medications, Surgery and Other Therapies}